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JACK PINE STEM RUST SURVEY CHEQUAMEGON NATIONAL FOREST JUNE, 1982

Prepared by:

KATHRYN ROBBINS, PATHOLOGIST
ST. PAUL FIELD OFFICE

ABSTRACT

Jack pine (Pinus banksiana) stands on the Chequamegon National Forest in northwestern Wisconsin were surveyed to determine the distribution, incidence, and impact of stem rust diseases. Gall rust was widespread and severe and sweetfern rust was serious in several stands on the northernmost Ranger District (Washburn). Stem rusts were of minor importance on the other Districts surveyed. Mortality due to all causes, including stem rusts, averaged more than 50% in stands over 50 years old on the Washburn District. A rotation age for jack pine of 40 to 50 years is recommended for this District.

INTRODUCTION

Jack pine (Pinus banksiana Lamb.) is one of the major sources of pulpwood in the Lake States and is also used for poles and lumber. Stem rusts are a group of diseases that cause reduced growth, degrade, and death of jack pine.

The five stem rusts that attack jack pine are:

Pine-oak (eastern) gall rust	Cronartium quercuum (Berk.) Miyabe ex Shirai f.sp. banksianae
Pine-pine (western) gall rust	Endocronartium harknessii (J. P. Moore) Y. Hiratsuka
Sweetfern rust	Cronartium comptoniae Arth.
Comandra rust	Cronartium comandrae Pk.
Stalactiform (cowwheat) rust	Cronartium coleosporioides (Diet & Holw.) Arth.

Although reports on the distribution and impact of some individual rusts in the Lake States are available (Anderson 1965; Anderson and French 1964; Guilkey et al. 1958; Hart et al. 1978; McGrath and Patton 1969; Mital 1982), there has been no comprehensive survey for all five stem rusts of jack pine in the Lake States National Forests. The Chequamegon National Forest was selected for the first part of such a

survey based on previous reports of widespread occurrence of rusts on that Forest. Other National Forests will be surveyed subsequently.

OBJECTIVE

The objective of this survey was to determine the distribution and impact of jack pine stem rusts on the Chequamegon National Forest.

MATERIALS AND METHODS

The Forest Supervisor's Office provided a computer print-out of all jack pine stands on the Chequamegon. Stands representing the range of age classes present on the Forest were selected from the print out. The number of stands per District selected for sampling was proportional to the distribution of jack pine on the Forest. Five stands each on the Glidden, Hayward, and Park Falls Districts and 24 stands on the Washburn District were surveyed. The stands sampled represented approximately 5 percent of the 808 jack pine stands on the Chequamegon.

For each stand, the site index, acreage, age, density (jack pine stems per acre) and basal area of jack pine (ft^2 per acre) were recorded. Presence of alternate hosts and whether they were infected with rust fungi was also recorded.

Two fixed radius plots were arbitrarily located in each stand. For stands more than 40 years old, 0.1 acre circular plots were used. In younger stands, circular plots were 0.02 acre.

For every jack pine in each plot, its condition (alive, dying, dead), crown position (dominant, codominant, intermediate, suppressed), DBH, and number of 8 foot sticks (to a 4 inch diameter top) were recorded. Type of rust infection, based on descriptions by Robbins et al. (1981), was recorded. Cull due to stem rusts was calculated in cords per acre using the number of 8-foot sticks that were unmerchantable due to rust infections, the diameter of the infected tree, and the composite volume Table 6 presented by Gevorkiantz and Olsen (1955). The presence of other pests of jack pine was also recorded.

If present, aeciospores were collected for later laboratory examination to distinguish between pine-pine and pine-oak rust (Anderson and French 1965) and to confirm the presence of comandra rust (Robbins et al. 1981).

RESULTS

Distribution

Gall rust was severe (i.e., greater than 50 percent of trees infected) in 21 of 24 stands on the Washburn District, but was severe in only one stand on the other three Districts (Table 1). Sweetfern rust was severe in only one stand surveyed: Washburn Compartment 190, Stand 22 (Table 1). Of the 1442 jack pines examined, 55 percent had gall rust and 2 percent had sweetfern rust. Neither comandra nor stalactiform rusts were observed in any of the stands surveyed.

To determine what factors influence the incidence of jack pine rusts, regression analyses were performed for five independent stand variables and the dependent variables of gall rust and sweetfern rust incidence. The independent variables were stand age, basal area, density, site index, and distance of the stand from Lake Superior.

Incidence of rust (i.e., percent of rust-infected trees) showed little correlation with any of the independent variables. Even when all five independent variables were included, the correlations were quite low: $r^2 = 0.65$ for gall rust and $r^2 = 0.15$ for sweetfern rust.

Aeciospores were collected from galls in several stands, but only one collection proved to be pine-oak rust. Other germination tests were inconclusive, probably due to overmaturity of the spores. No rust spores were present on the alternate hosts observed during the survey.

Impact

Less than one percent of the trees surveyed (14 of 1,442) had broken at stem galls; average DBH of these trees was 3.3 inches.

Approximately 0.1 cord of wood per acre was lost due to stem galls and rust cankers. More than 78 percent of the cull on which this figure is based occurred in one 57-year-old stand on the Washburn District (Compartment 109, Stand 3).

Conks of the common decay fungus Phellinus (formerly Fomes) pini (Thore ex Fr.) Pilat were found on 7 of the 1442 jack pines surveyed. On five of these trees, the conks were associated with large sweetfern rust cankers. Volume lost due to decay was not measured.

Mortality of jack pine in the stands surveyed ranged from 0 to 63 percent and generally increased with age (Table 2). A combination of many factors led to the death of these trees including armillaria root rot, drought, gall rust, jack pine budworm defoliation, and suppression. In the stands more than 50 years old (all on the Washburn District), mortality averaged more than 50 percent.

Damage by several other pests (see Appendix) was observed, but the amount of damage was not serious.

DISCUSSION

The level of gall rust infection on the northern half of Washburn District is probably the highest in the Lake States. Previous surveys have found only pine-oak rust in northwestern Wisconsin (McGrath and Patton 1969; K. Robbins, unpublished), but pine-pine rust may occur there as well. Pine-pine rust does not require an alternate host to complete its life cycle. By spreading directly from pine to pine, this rust is potentially a more serious disease than pine-oak rust which must spend part of its life on oak leaves.

Gall rust does not appear to be serious on the other Districts. The higher incidence of gall rust on the Washburn District may be due to the many continuous acres of jack pine coupled with the availablity of alternate hosts (i.e., oaks). This situation has existed since the 1930's when extensive areas were planted with jack pine seedlings. There are fewer jack pine stands on the other Districts, and the stands are more isolated from one another. In addition, the climate may be less conducive to infection.

Although it is likely that gall rust causes reduced growth, this has not been proven. Losses due to stem breakage and cull while more easily documented, did not cause a great deal of damage in the stands surveyed. In addition to the cull left in the woods due to rust infections, wood in harvested rust-infected bolts may yield pulp of lesser quantity and quality pulp as has been shown for fusiform rust-infected wood in the southern U.S. (Blair et al. 1974).

Growth loss, cull, and mortality associated with sweetfern rust cankers has been documented (Gross et al. 1978). In addition to the cull due to stem deformity and resin-soaked wood caused by this disease, decay in the cankered portion of the butt log causes considerable cull. Our results confirm the association of Phellinus pini decay with these cankers. Openings in the bark created by a canker allow spores of this fungus to infect and decay the wood behind the canker. Although we observed conks on only 7 trees, decay was undoubtedly present in many others which had not yet produced conks (i.e., "hidden decay"). Blanchette (1982) recently reported this decay - canker association in trees previously thought to be too young to contain decay.

RECOMMENDATIONS

1. Because mortality on the Washburn Ranger District is much greater in stands more than 50 years old (Table 2), a rotation for jack pine of 40 to 50 years is indicated.
2. Stands that are beginning to break up should be salvaged as quickly as possible.
3. Jack pine stands that are clearcut should be replaced by a diversity of species including red and jack pine, white spruce, and hardwoods according to their site requirements.
4. Regeneration should be done in isolated blocks (less than 40 acres) to avoid the present situation of many continuous acres of a single tree species (i.e., jack pine).
5. To alert nursery managers to the possibility of rust-infected planting stock, areas planted with jack pine should be checked one year after planting for swellings or galls on stems.

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Table 1. Incidence of gall rust, sweetfern rust, and mortality in jack pine stands on the Chequamegon National Forest, June, 1982.

DISTRICT	COMPARTMENT	STAND	ORIGIN	TREES WITH GALL RUST (%)	TREES WITH SWEETFERN RUST (%)	MORTALITY[1/] (%)
Washburn	190	22	1933	94	30	30
	204	24	1921	98	0	61
	89	15	1940	80	0	36
	153	19	1927	92	0	55
	109	3	1925	84	9	35
	228	61	1950	97	3	9
	180	17	1949	100	4	12
	171	5	1949	92	0	42
	163	7	1948	98	0	21
	141	10	1947	84	2	39
	171	21	1953	89	0	8
	204	14	1955	75	0	35
	162	1	1958	100	0	30
	210	25	1959	67	7	0
	154	19	1968	50	0	9
	229	19	1968	75	0	5
	227	51	1969	83	9	0
	227	48	1964	71	0	0
	224	1	1969	88	4	16
	168	12	1977	41	0	0

[1/] Mortality of jack pine due to all causes.

DISTRICT	COMPARTMENT	STAND	ORIGIN	TREES WITH GALL RUST (%)	TREES WITH SWEETFERN RUST (%)	MORTALITY (%)
Washburn	210	20	1973	71	0	13
	92	28	1976	0	0	0
	143	11	1974	28	0	0
	195	6	1972	69	0	6
Glidden	124	31	1937	33	0*	7
	59	27	1946	0	0	46
	17	16	1938	69	0	12
	100	14	1936	0	0	21
	165	14	1978	0	0	0
Hayward	37	6	1938	7	0	40
	21	27	1945	0	0	63
	40	2	1942	8	0	24
	61	4	1937	35	0	25
	118	1	1972	0	0	7
Park Falls	38	3	1936	24	0	18
	42	3	1947	2	0	20
	104	9	1954	0	0	32
	31	18	1942	0	0	24
	105	10	1945	0	0	10

*Sweetfern rust was observed on jack pine in this stand, but not in the survey plots.

Table 2. Mortality of jack pine due to all causes, by age class.

AGE CLASS (YR)	STANDS SURVEYED (NO.)	AVERAGE MORTALITY (%)
0-10	7	3.7
11-20	5	6.0
21-30	5	21.0
31-40	11	28.2
41-50	8	23.6
51-60	3	50.3

APPENDIX

Minor Pests of Jack Pine on the Chequamegon N.F.

	Scientific Name
Diseases:	
tar spot needlecast	*Davisomycella ampla* (Dav.) Dark
pine needle rust	*Coleosporium asterum* (Diet.) Syd.
scleroderris canker	*Gremmeniella abietina* (Lagerb.) Morelet
stem canker	unknown cause
Insects:	
Zimmerman pine moth	*Dioryctria zimmermani* (Grote)
white pine weevil	*Pissoides strobi* (Peck)
pine spittlebug	*Aphrophora parallela* (Say)
northern pitch twig moth	*Petrova albicapitana* (Busck)
Animals:	
sapsucker	*Sphyrapicus varius* (L.)
deer	*Odocoileus virginianus* (Odvi)
squirrel	*Tamiasciurus* spp.
porcupine	*Erethizon dorsatum* (Erdo)